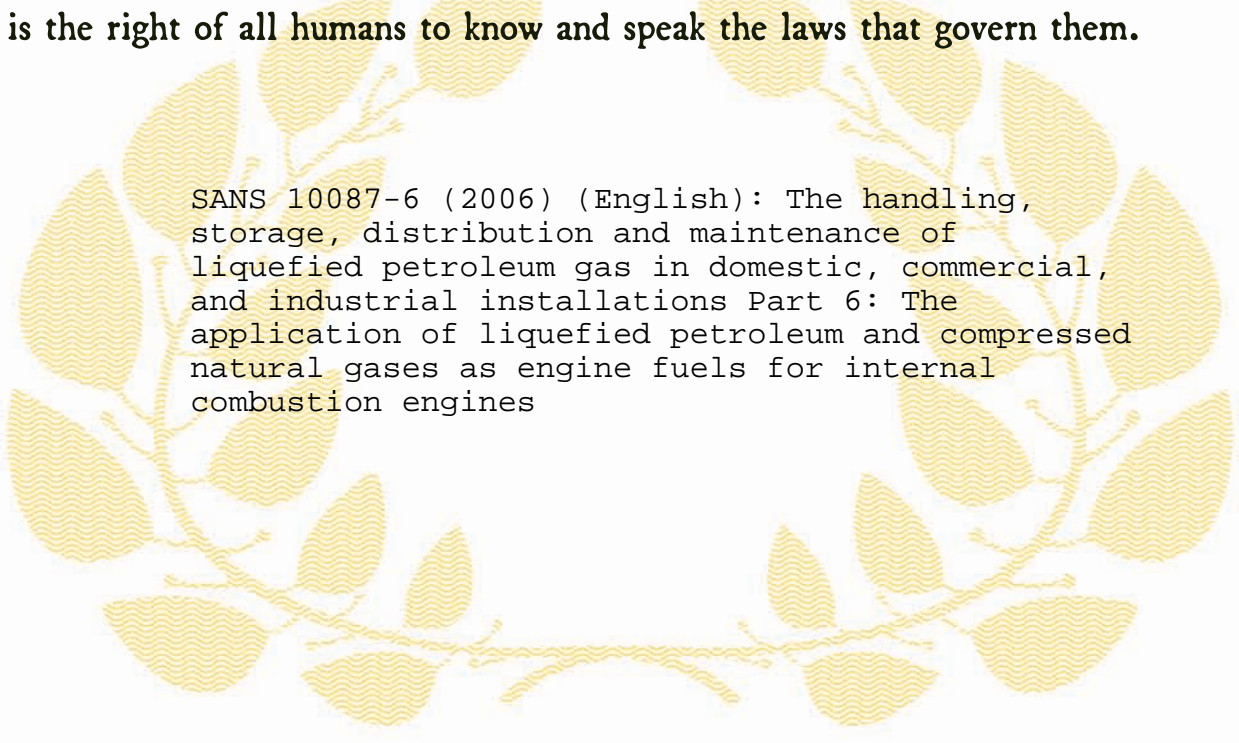




Republic of South Africa

EDICT OF GOVERNMENT

In order to promote public education and public safety, equal justice for all, a better informed citizenry, the rule of law, world trade and world peace, this legal document is hereby made available on a noncommercial basis, as it is the right of all humans to know and speak the laws that govern them.



SANS 10087-6 (2006) (English): The handling, storage, distribution and maintenance of liquefied petroleum gas in domestic, commercial, and industrial installations Part 6: The application of liquefied petroleum and compressed natural gases as engine fuels for internal combustion engines



BLANK PAGE



SOUTH AFRICAN NATIONAL STANDARD

**The handling, storage, distribution and
maintenance of liquefied petroleum
gas in domestic, commercial, and
industrial installations**

Amdt 1

**Part 6: The application of liquefied petroleum
and compressed natural gases as engine
fuels for internal combustion engines**

SANS 10087-6:2006

Edition 4.1

Table of changes

Change No.	Date	Scope
Amdt 1	2006	Amended to update the general title, the foreword and referenced standards, to update maintenance requirements for the vehicle, to include training requirements and a checklist for the driver and filler of the vehicle, and to include requirements regarding the compatibility of gas components used on converted vehicles.

Foreword

This South African standard was approved by National Committee StanSA SC 5120.19D, *Gas supply, handling and control (fuel and industrial gases) – Alternative gas fuels for automotive use*, in accordance with procedures of Standards South Africa, in compliance with annex 3 of the WTO/TBT agreement.

This part of SANS10087 was published in November 2006. This edition cancels and replaces edition 4 (SANS 10087-6:2003).

A vertical line in the margin shows where the text has been technically modified by amendment No. 1.

Annexes B and F form an integral part of this standard. Annexes A, C, D, E and G are for information only.

SANS 10087 consists of the following parts, under the general title, *The handling, storage, distribution and maintenance of liquefied petroleum gas in domestic, commercial, and industrial installations*:

Part 1: Liquefied petroleum gas installations involving gas storage containers of individual water capacity not exceeding 500 L and a combined water capacity not exceeding 3 000 L per installation.

Part 2: Installations in mobile units and small non-permanent buildings.

Amdt 1

Part 3: Liquefied petroleum gas installations involving storage vessels of individual water capacity exceeding 500 L.

Part 4: Transportation of LPG in bulk by road.

Part 6: The application of liquefied petroleum and compressed natural gases as engine fuels for internal combustion engines.

Part 7: Storage and filling sites for refillable liquefied petroleum gas (LPG) containers of capacity not exceeding 9 kg.

Part 8: The fuelling of fork lift trucks and other LP gas operated vehicles.

Part 10: Mobile filling stations for refillable liquefied petroleum gas (LPG) containers of capacity not exceeding 9 kg.

Introduction

This part of SANS 10087 represents a minimum standard of good practice and therefore takes the form of guidelines. Compliance with it does not confer immunity from relevant legal requirements (including municipal and other by-laws), and the authority having jurisdiction, i.e. the approving authority (see 3.2) should be approached in circumstances where mandatory requirements are applicable. Should anything in this part of SANS 10087 conflict with the provisions of Government, Provincial or Municipal Regulations, the Government, Provincial, or Municipal Regulations shall take precedence.

When Sub-Committee, StanSA SC 5120.19D, commenced with the revision of this South African standard, it took as its basis, the ECE Regulation 67 and ECE Regulation 110. In taking this decision, StanSA SC 5120.19D, agreed that this standard would differ slightly from the Regulations. Consequently, the standard has been subdivided as follows:

Retrofitting of vehicles for LPG;

Retrofitting of vehicles for CNG;

Forklift trucks; and

Stationary and portable engines in buildings.

Contents

	Page
Foreword	
Introduction	
1 Scope	3
2 Normative references	3
3 Definitions	4
4 Retrofitting of vehicles for LPG	6
5 Retrofitting of vehicles for CNG	19
6 Forklift trucks	32
7 Stationary and portable engines in buildings	33
Annex A (informative) Typical conversion of a petrol engine	34
Annex B (normative) Provisions regarding CNG and LPG identification of M ₂ , M ₃ and N category vehicles	35
Annex C (informative) Fuel tank mounting, design guidelines	36
Annex D (informative) Filling receptacle for CNG fuel tanks	37
Annex E (informative) Connections for articulated vehicles	38
Annex F (normative) Safety shut-down system	39
Annex G (informative) Pressure/strength test procedure at a glance	41
Bibliography	42

The handling, storage, distribution and maintenance of liquefied petroleum gas in domestic, commercial, and industrial installations

Amdt 1

Part 6:

The application of liquefied petroleum and compressed natural gases as engine fuels for internal combustion engines

1 Scope

This part of SANS 10087 covers the safe use of liquefied petroleum gas and compressed natural gas as fuels for internal combustion engines and for the safe operation of equipment manufactured for conversions.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards can be obtained from Standards South Africa.

BS 3212, *Specification for flexible rubber tubing, rubber hose and rubber hose assemblies for use in LPG vapour phase and LPG/air installations.*

BS 5292, *Specification for jointing materials and compounds for installations using water, low-pressure steam or 1st, 2nd and 3rd family gases.*

EN 837-1, *Pressure gauges – Part 1: Bourdon tube pressure gauges – Dimensions, metrology, requirements and testing.*

ISO 11439, *Gas cylinders – High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles.*

SANS 62-2 (SABS 62-2), *Steel pipes – Part 2: Screwed pieces and pipe fittings of nominal size not exceeding 150 mm.*

SANS 252, *Metallic hose assemblies for liquid petroleum gases and liquefied natural gases.* Amdt 1

SANS 460, *Plain-ended solid drawn copper tubes for potable water.*

SANS 1792-1 (SABS 1792-1), *Refillable welded steel gas cylinders – Part 1: LPG fuel tanks for motor vehicles.*

SANS 10087-6:2006

Edition 4.1

SANS 10019 (SABS 019), *Transportable metal containers for compressed gas – Basic design, manufacture, use and maintenance.*

SANS 10086-1, *The installation, inspection and maintenance of equipment used in explosive atmospheres – Part 1: Installations including surface installations on mines.*

SANS 10087-1, *The handling, storage, distribution and maintenance of liquefied petroleum gas in domestic, commercial, and industrial installations – Part 1: Liquefied petroleum gas installations involving gas storage containers of individual water capacity not exceeding 500 L and a combined water capacity not exceeding 3 000 L per installation.*

SANS 10087-3, *The handling, storage, distribution and maintenance of liquefied petroleum gas in domestic, commercial, and industrial installations – Part 3: Liquefied petroleum gas installations involving storage vessels of individual water capacity exceeding 500 L.*

SANS 10087-8 (SABS 087-8), *The handling, storage, distribution and maintenance of liquefied petroleum gas in domestic, commercial, and industrial installations – Part 8: The fuelling of fork lift trucks and other LP gas operated vehicles.*

SANS 10108, *The classification of hazardous locations and the selection of apparatus for use in such locations.*

SANS 10400 (SABS 0400), *The application of the National Building Regulations.*

UN/ECE Regulation No. 67 Uniform provisions concerning:

- I. Approval of specific equipment of motor vehicles using liquefied petroleum gases in their propulsion system.
- II. Approval of vehicle fitted with specific equipment for the use of liquefied petroleum gases in its propulsion system with regard to the installation of such equipment.

UN/ECE Regulation No. 110 Uniform provisions concerning:

- I. Specific components of motor vehicles using compressed natural gas (CNG) in their propulsion system.
- II. Vehicles with regard to the installation of specific components of an approved type for the use of compressed natural gas (CNG) in their propulsion system.

3 Definitions

For the purposes of this part of SANS 10087, the following definitions apply:

3.1

approved

approved by the approving authority or his official representative (see 4.7 in SANS 10019:2001)

3.2

approving authority

approving authority means the Department of Labour

3.3

clearance

shortest vertical distance between ground level and the bottom of the tank or the lowest extremity of the lowest fitting on the tank housing

3.4**compressed natural gas****CNG**

mixture of hydrocarbon gases and vapours consisting principally of methane in gaseous form that has been compressed for use as a vehicular fuel

3.5**confined space**

enclosed, restricted, or limited space in which, because of its construction, location or contents, or any work activity carried on therein, a hazardous substance may accumulate or an oxygen-deficient atmosphere may occur

3.6**fuel tank****3.6.1****permanently mounted fuel tank**

fuel tank that is permanently secured to a vehicle or to a stationary engine and that is filled while still secured in the permanent position

3.6.2**removable fuel tank**

fuel tank that is not permanently secured in the mounted position and that can be readily removed for the purpose of filling

3.7**liquefied petroleum gas****LPG**

mixture of light hydrocarbons (predominantly propane, propene, butane and butene) that is gaseous under conditions of ambient temperatures and pressure, and that is maintained in the liquid state by an increase of pressure or a lowering of temperature

3.8**motor vehicle**

motor vehicle comprising one of the following:

3.8.1**category M₁ motor vehicle**

motor vehicle used for the carriage of passengers, that has at least four wheels, and that has seating accommodation for not more than eight passengers in addition to the driver of the vehicle

3.8.2**category M₂ motor vehicle**

motor vehicle used for the carriage of passengers, that has at least four wheels, that has seating accommodation for more than eight passengers in addition to the driver of the vehicle, and that has a maximum mass not exceeding 5 t

3.8.3**category M₃ motor vehicle**

motor vehicle used for the carriage of passengers, that has at least four wheels, that has seating accommodation for more than eight passengers in addition to the driver of the vehicle, and that has a maximum mass exceeding 5 t

3.8.4**minibus**

motor vehicle that is designed or modified solely for the conveyance of not more than 15 seated passengers in addition to the driver of the vehicle and that does not provide for the carriage of standing passengers

SANS 10087-6:2006

Edition 4.1

3.8.5

category N motor vehicle

goods vehicle that has at least four wheels, or that has three wheels and a maximum mass exceeding 1 t

3.8.6

category N₁ motor vehicle

motor vehicle that has a maximum mass not exceeding 3,5 t, that has at least four wheels (or provided that the maximum mass exceeds 1 t, at least three wheels), and that is used for the carriage of goods

3.8.7

category N₂ motor vehicle

vehicle that is used for the carriage of goods and that has a maximum mass of more than 3,5 t but not more than 12 t

3.8.8

category N₃ motor vehicle

vehicle that is used for the carriage of goods and that has a maximum mass exceeding 12 t

3.9

new vehicle

vehicle which has been fitted or converted to operate with LPG or CNG before its first registration

3.10

registered carburation installer

3.10.1

registered LPG carburation installer

person having the ability, appropriate training, knowledge and experience in the conversion of internal combustion engines to operate on LPG, to supervise or to carry out the work being undertaken in a safe and proper manner and registered in accordance with the requirements of the Department of Labour

3.10.2

registered CNG carburation installer

person having the ability, appropriate training, knowledge and experience in the conversion of internal combustion engines to operate on CNG, to supervise or to carry out the work being undertaken in a safe and proper manner and registered in accordance with the requirements of the Department of Labour

3.11

working pressure

maximum gauge pressure that is permitted in a fuel tank when in use

4 Retrofitting of vehicles for LPG

4.1 General

4.1.1 The exhaust gases from a properly adjusted engine burning LPG are practically odourless and will also not irritate the eyes. Although the quantity of carbon monoxide contained in the exhaust gas from a properly adjusted LPG engine is small, care should be taken to ensure that when the engine is running, the maximum concentration of carbon monoxide in air for an 8 h exposure in a confined space, does not exceed a volume fraction of 50×10^{-6} .

NOTE Typical conversion is given in annex A.

4.1.2 A vehicle in transit may draw fuel from its cargo vessel provided that the cargo vessel is mounted immediately onto the vehicle and not on the trailer or semi-trailer.

4.1.3 Where more than one LPG fuel tank is installed in a category

- a) **M₁**, **N₁** motor vehicle or minibus, the combined water capacity in such tanks shall not exceed 150 L,
- b) **M₂** or **N₂** motor vehicle with a maximum mass not exceeding 5 t, the water capacity of such fuel tanks shall not exceed 800 L, and
- c) **M₃** or **N₂** motor vehicle with a mass exceeding 5 t, and **N₃** vehicles, the water capacity of the LPG fuel tanks shall not exceed 1 100 L. (See SANS 1792-1).

4.1.4 All vehicles equipped with permanently mounted LPG fuel tanks shall

- a) be fuelled outdoors, and
- b) have fuelling equipment that is suitable for LPG refuelling of vehicles (see SANS 10087-3).

Amdt 1

4.1.5 A fuel tank on category **M₁**, **M₂**, **M₃** and **N₁** motor vehicles shall be designed for permanent mounting on the vehicles.

4.1.6 Proprietary equipment may not be modified, however, the installation of the proprietary equipment may necessitate modifications. Such modifications, periodic inspection and maintenance of the gas system shall only be done by a registered LPG carburation installer in accordance with this standard. The inspection and service maintenance intervals shall not exceed those recommended by the vehicle manufacturer in accordance with normal vehicle servicing.

Amdt 1

4.1.7 Vehicles with more than one fuel system shall

- a) have a fuel selection system to ensure that not more than one fuel is supplied to the engine at any time, and
- b) have a short overlap time to allow switching-over.

4.1.8 When an engine is converted for the exclusive use of LPG, the original fuel system (including the fuel tank) shall be removed or otherwise so controlled that it cannot be rendered operative inadvertently.

4.1.9 Notwithstanding the provision of 4.1.7, in the case of a conversion system that is designed for the use of more than one fuel, it is permitted to supply more than one fuel at the same time.

Amdt 1

4.1.10 Welding operations

- a) on fuel lines should be carried out only after the lines have been rendered gas-free in an approved manner, and
- b) on non-gas parts of a vehicle and in the vicinity of the fuel system, shall not be carried out until the gas supply has been shut-off completely.

WARNING: Because of the fire and explosion risk involved when LPG is ignited, extreme care should be taken when welding operations are required to be carried out in the vicinity of LPG.

SANS 10087-6:2006

Edition 4.1

4.1.11 Only registered LPG carburation installers shall carry out the installation, periodic inspection and maintenance of the gas system on vehicles. The inspection and service maintenance intervals shall not exceed those recommended by the vehicle manufacturer in accordance with normal vehicle servicing. **Amdt 1**

4.1.12 The material used in the system shall be suitable for use with LPG.

4.1.13 All parts of the system should be fastened in a proper way.

4.1.14 The LPG system should be installed such that it has the best possible protection against damage, such as damage due to moving vehicle components, collision, grit or due to the loading or unloading of the vehicle or the shifting of such loads.

4.1.15 No appliances shall be connected to the LPG system other than those strictly required for the proper operation of the vehicle's engine.

4.1.16 An LPG fuel tank shall be so positioned as to minimize the possibility of damage to the tank and its fittings.

NOTE A fuel tank located at the rear of a truck or bus and protected by substantial bumpers will be considered to comply with this recommendation.

4.1.17 There shall be no gas conveying connections in the passenger compartment or enclosed luggage compartment with the exception of

- a) the connections on the gas-tight housing, and
- b) the connection between the gas tube or hose and the filling unit if this connection is fitted with a sleeve which is resistant against LPG and any leaking gas will be discharged direct to the atmosphere.

4.1.18 In all other cases, apart from 4.1.17, where the fuel tank is installed inside a passenger-conveying vehicle:

- a) the tank, connections and associated piping (including the extended filler and relief valve), shall be enclosed in a fixed compartment, and
- b) the valves of the tank shall be in a gas-tight housing.

4.1.19 In addition, the compartment (see 4.1.18) shall be vented (at its lowest point) to the outside of the vehicle. **Amdt 1**

4.1.20 The compartment shall be constructed of impervious material that is not normally susceptible to physical damage.

4.1.21 No component of the LPG system shall be located within 100 mm of the exhaust system or similar heat source, unless such components are shielded against heat.

4.1.22 No component of the LPG system, including any protective materials which form part of such components, shall project beyond the external surface of the vehicle, with the exception of the filling unit provided that this does not project more than 10 mm beyond the nominal line of the body panel. It is recommended that the filling unit is mounted to the body panel of the vehicle and is always easily accessible. **Amdt 1**

NOTE Because of the gas-tight design of the housing on the filler tank (see SANS 1792-3) there is no specific need to isolate the fuel tank from possible sources of ignition.

4.1.23 The clearance between an LPG fuel tank and ground level shall

- a) be as large as practicable, and
- b) not be less than the minimum road clearance of the lowest part of the vehicle under maximum spring deflection.

4.1.24 A fuel tank shall be securely mounted on the vehicle to prevent it from jarring loose, slipping or rotating.

4.1.25 The fastenings of the fuel tank shall be designed and constructed with a minimum safety factor of four, based on applied forces of ten times the mass of the filled tank in the longitudinal (along the length of the vehicle) direction and twice the mass of the filled tank in all other directions.

4.1.26 LPG fuelled M₂, M₃ and N category vehicles shall be identified and marked in accordance with the requirements given in annex B. **Amdt 1**

4.2 Fuel tanks for vehicles

4.2.1 General

Fuel tanks intended for use on vehicles shall comply with a standard approved for this purpose (see also SANS 10019, SANS 1792-1 or UN/ECE Regulation No. 67 annex 10).

4.2.2 Installation of the fuel tank

4.2.2.1 The fuel tank shall not be installed in the engine compartment.

4.2.2.2 The permanent fuel tank shall be installed in the correct operating position, according to the instruction from the manufacturer.

4.2.2.3 Care shall be taken to ensure that there is no metal to metal contact between the tank and the body of the vehicle other than the fixing points.

4.2.2.4 The fuel tank shall

- a) have permanent fixing points to secure it to the motor vehicle, or
- b) be secured to the motor vehicle by a fuel tank frame and fuel tank straps.

4.2.2.5 If more than one LPG fuel tank is connected to a single delivery tube,

- a) each fuel tank shall be fitted with a non-return valve installed downstream of the remotely controlled service valve;
- b) a tube pressure relief valve shall be installed in the delivery tube, downstream of the non-return valve; and
- c) an approved filter system shall be placed upstream of the non-return valve(s) to prevent fouling of the non-return valve(s).

4.2.2.6 A non-return valve and tube pressure relief valve shall not be required if the backflow pressure of the remotely controlled service valve in the closed position exceeds 500 kPa.

4.2.2.7 In that case (see 4.2.2.6) the control of the remotely controlled service valve shall be constructed such that it is impossible for more than one remotely controlled valve to be open at any time. The overlap time to allow switching shall not exceed 2 min.

4.2.2.8 The fuel tank shall be mounted such that the effectiveness of any vehicle crumple zone is not impaired.

4.2.2.9 Where possible, the fuel tank should be located centrally in the vehicle to balance out the weight distribution of the cylinder.

4.2.2.10 The fuel tank shall be so located as to minimize the possibility of damage to the fuel tank and its fittings.

4.2.2.11 When the fuel tank is installed on the back of a light delivery vehicle or truck that might be used for the conveyance of passengers or goods, and whether such a vehicle is fitted with a canopy or not, the fuel tank shall be protected by an enclosed fixed compartment (due regard being given to access to the valves).

4.2.2.12 Such a compartment (see 4.2.2.11) should be constructed of material that is normally not susceptible to physical damage.

4.3 Filling operation

4.3.1 A fuel tank installed inside a passenger-conveying vehicle (i.e. in the luggage compartment of the vehicle or elsewhere) shall be filled only through an extended filler tube.

4.3.2 The inlet of filler tube (see 4.3.1) shall be mounted on the outside of the vehicle.

4.3.3 The volume of liquefied petroleum gas filled into any fuel tank shall not exceed 80 % of the volume of the tank.

4.3.4 Filling shall be carried out in accordance with the relevant recommendations of SANS 10087-3. The use of filling adaptors is prohibited. **Amdt 1**

4.4 Fuel tank valves and accessories

4.4.1 General

4.4.1.1 The LPG equipment as installed in the vehicle shall function in such a manner that the maximum operating pressure for which it has been designed and approved cannot be exceeded.

4.4.1.2 Fuel tank valves, connections and piping shall, where reasonably practical, be protected to prevent damage caused by accidental contact with stationary objects or by loose objects thrown up from the road.

4.4.1.3 All valves shall be safeguarded against damage caused by collision, overturning or any other accident to the vehicle.

4.4.1.4 Fuel tank valves and accessories shall not be manufactured of cast iron.

4.4.1.5 Safety valves shall comply with the recommendations given in 4.8.

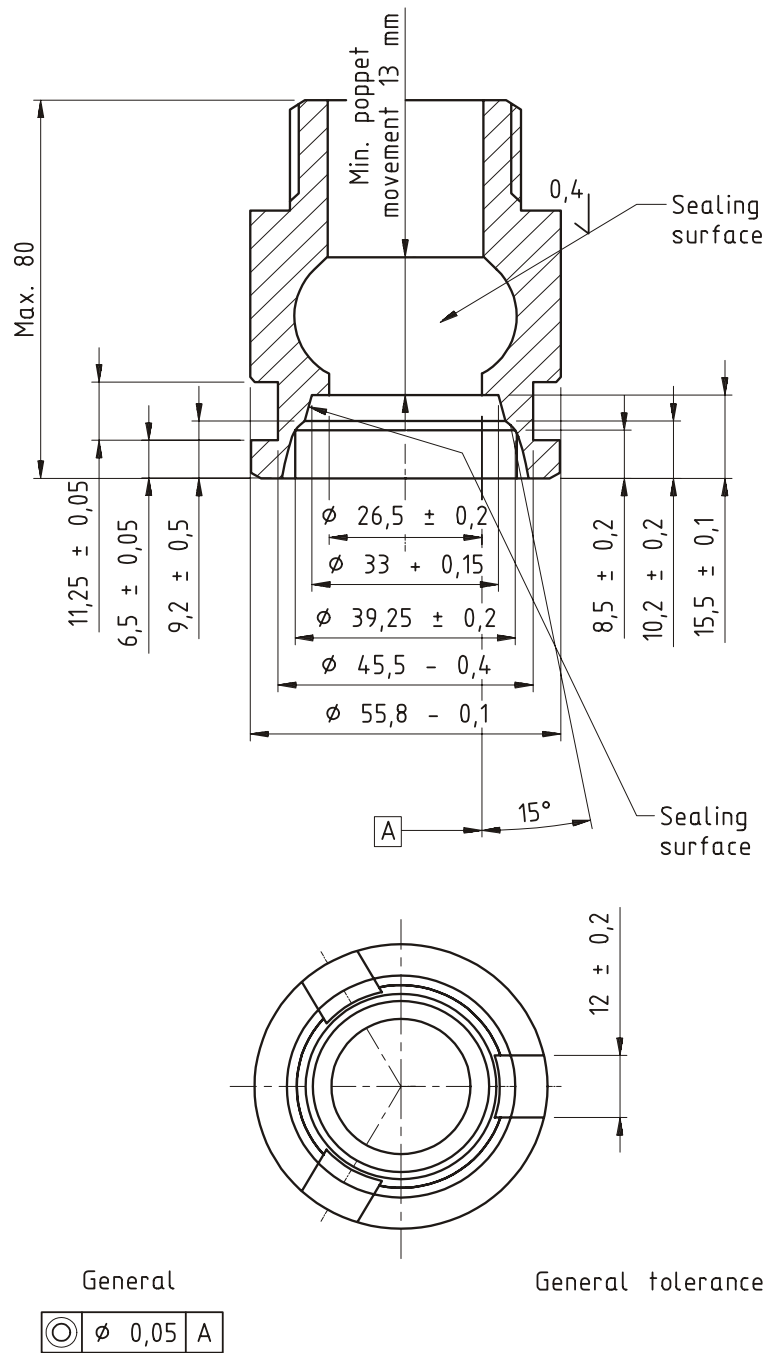
4.4.1.6 All components shall comply with the relevant requirements of UN/ECE Regulation No. 67 or Underwriters Laboratories (UL) listed components.

4.4.2 Filling connections

4.4.2.1 Each filling connection shall be fitted with a double-seated back-pressure check valve, or with a positive shut-off valve used in conjunction with a back-pressure check valve.

4.4.2.2 Filling units shall be as shown in figure 1.

Amdt 1



Drg.589

Figure 1 — Recommended LPG filling nozzle

Amdt 1

4.4.3 The LPG system

4.4.3.1 An LPG system shall contain at least the following components:

- a) fuel tank;
- b) manual shut off valve;
- c) 80 % stop valve;
- d) contents indicator;
- e) pressure relief valve;
- f) remotely controlled service valve with excess flow valve;
- g) pressure regulator and vaporizer, which may be combined;
- h) remotely controlled shut-off valve;
- i) filling unit;
- j) gas tubes and hoses;
- k) gas carrying connections between the LPG system components;
- l) injector or gas injection device or gas mixing piece;
- m) electronic control unit; and
- n) pressure relief device (fuse).

4.4.3.2 The system shall include gas-tight housing, covering the accessories fitted to the fuel tank.

4.4.3.3 Only compatible components shall be used when installing, servicing or replacing a gas component on a converted vehicle. **Amdt 1**

4.4.3.4 All components of the gas system shall be fitted in accordance with the manufacturer's recommendations. **Amdt 1**

4.4.4 Accessories to the fuel tank

4.4.4.1 Remotely controlled service valve with excess flow-valve on the fuel tank

4.4.4.1.1 The remotely controlled service valve with excess flow valve shall be installed direct to the fuel tank, without any intervening fittings.

4.4.4.1.2 The remotely controlled service valve with excess flow-valve shall be controlled such that

- a) it is automatically closed when the engine is not running, irrespective of the position of the ignition switch, and
- b) it remains closed as long as the engine is not running.

4.4.4.2 Spring loaded pressure relief valve in the fuel tank

The spring loaded pressure relief valve

- a) shall be installed in the fuel tank in such a manner that it is connected to the vapour space and can discharge to the surrounding atmosphere, and
- b) may discharge into the gas-tight pressure housing if that gas-tight housing fulfils the requirements of 4.4.4.5.

4.4.4.3 80 % stop valve

The automatic filling level limiter shall be

- a) suitable for the fuel tank it is fitted to, and
- b) installed in the appropriate position to ensure that the fuel tank cannot be filled to more than 80 % of its water capacity.

4.4.4.4 Contents indicator

The level indicator shall be

- a) suitable for the fuel tank it is fitted to, and
- b) installed in the appropriate position.

4.4.4.5 Gas-tight housing on the fuel tank

4.4.4.5.1 A gas-tight housing over the fuel tank fittings, which fulfils the requirements of 4.4.4.5.2 to 4.4.4.5.6 inclusive, shall be fitted to the fuel tank.

4.4.4.5.2 The gas-tight housing shall be vented to the atmosphere by the use of two connecting hoses positioned in such a manner that one hose forces air into the housing and the other hose draws air out of the housing.

4.4.4.5.3 The ventilation opening of the gas-tight housing shall

- a) point downwards at the point of exit from the motor vehicle,
- b) not discharge into a wheel arch, nor
- c) be aimed at the heat source such as the exhaust.

4.4.4.5.4 Any connecting hose and lead-through in the bottom of the bodywork of the motor vehicle for ventilation of the gas-tight housing shall have a minimum clear opening of 450 mm².

4.4.4.5.5 If a gas, or any other type of tube or any electrical wiring is installed in the connecting hose and lead-through, the clear opening shall also be at least 450 mm².

4.4.4.5.6 The gas-tight housing and connecting hoses shall be gas-tight at a pressure of 10 kPa with the apertures closed off, and show no permanent deformation, with a maximum allowed leak rate of 100 cm³/h.

4.4.4.5.7 The connecting hose shall be secured in a proper way to the gas-tight housing and the lead-through to ensure that a gas-tight joint is formed.

4.5 Piping, fittings and other components

4.5.1 Materials control

4.5.1.1 Materials used in the pipe system should comply with at least the requirements given in the appropriate clauses of the following standards:

Seamless steel pipes and fittings	SANS 62-2	
Copper tubes	SANS 460	
Flexible tubing or hose	BS 3212 (or similar)	
Rubber hose	SANS 252 (Types 1 and 2)	Amdt 1
Jointing compounds	BS 5292	

4.5.1.2 When pipes and fittings contain any of the following materials, such material shall be protected against the potential hazard as indicated:

a) brass: seasonal cracking;

NOTE Brass tubes complying with the relevant requirements of SANS 460 are considered suitable.

b) aluminium: corrosion; and

c) lead: creep.

4.5.1.3 In the case of threaded connections, the mating threads shall be tapered and matched.

4.5.1.4 Particular care should be taken to ensure that mating threads are of the same type, form and designation.

4.5.1.5 No joint shall be made by over-torque of non-mating threads or relying on the jointing compounds for sealing.

4.5.1.6 Gas tubes shall be made of seamless material: either copper or stainless steel or steel with corrosion-resistant coating.

4.5.1.7 If seamless copper is used, the tube shall be protected by a rubber or plastic sleeve.

4.5.1.8 The gas tube shall have

a) an outer diameter not exceeding 12 mm, and

b) a wall thickness of at least 0,8 mm.

4.5.1.9 The gas tube may be manufactured from a non-metallic material if the tube fulfils the requirements of 4.5.1.8, 4.5.1.12 and BS 3212.

4.5.1.10 The gas tube may be replaced by a gas hose if this hose fulfils the requirements of 4.5.1.12.

4.5.1.11 Gas tubes, other than non-metallic gas tubes, shall be secured such that they shall not be subjected to vibration or stresses by use of suitable brackets and self-tapping screws fitted at intervals of not more than 300 mm, where possible.

4.5.1.12 Gas hoses and non-metallic gas tubes shall be secured such that they are not subjected to stresses by use of suitable brackets and self-tapping screws fitted at intervals of not more than 300 mm, where possible.

4.5.1.13 At the fixing point, the gas tube or hose shall be fitted with a protective material.

4.5.1.14 Gas tubes or hoses shall not be located at jacking points.

4.5.1.15 At passages, the gas tubes or hoses, whether fitted with a protective sleeve or not, shall be fitted with a protective material.

4.5.2 Liquid fuel pipeline

The bore of a liquid fuel pipeline shall be large enough to ensure the effective and continual operation of the relevant excess-flow valve (see 4.4.4.1) in case of fracture or disconnection of the pipeline.

4.5.3 Steel tubing

Steel tubing shall be externally protected against corrosion.

4.5.4 Fuel lines installation

Fuel lines shall

- a) be so installed, braced and supported as to minimize the effects of vibration, strain and wear,
- b) have clearances between them and components of the exhaust system and sources of electrical hazards that are acceptable, and
- c) include a flexible connection between the mountings on the vehicle chassis and the engine.

4.5.5 Flexible hose

Flexible hose that passes through sheet metal shall be so installed that it is protected against abrasion by the sheet metal.

4.5.6 Length of flexible hose

Flexible hose between any parts of the fuel system that are mounted on the body or chassis of a vehicle and parts that are mounted on the engine, shall be of sufficient length to allow for vibration of and relative movement between parts.

4.5.7 Jointing compound and testing for leaks

4.5.7.1 A suitable pipe-jointing compound shall be used on all gas threads.

4.5.7.2 All fuel system connections, and the fuel tank and its valves and fittings shall, when first assembled (and thereafter when deemed necessary), be tested for leaks by using a soap-and-water (or equivalent) solution while the system is subjected to an LPG pressure of $610 \text{ kPa} \pm 10 \text{ kPa}$.

4.5.7.3 Alternatively, provided that the necessary safety precautions (such as purging of the system) are taken, the fuel tank, together with its associated valves and fittings, may be tested separately with an air pressure of at least $610 \text{ kPa} \pm 10 \text{ kPa}$.

4.5.8 Protection of valves and connections

4.5.8.1 In the case of a removable fuel tank, the protection for valves and connections shall be

- a) permanently attached to the tank, and
- b) so designed and fitted as to protect the valves and connections against damage during removal, filling and re-installation of the tank.

4.5.8.2 There shall be no gas-conveying connections in the passenger compartment or enclosed luggage compartment with the exception of

- a) the connections on the gas-tight housing, and
- b) the connection between the gas tube or hose and the filling unit if this connection is fitted with a sleeve which is resistant against LPG, and any leaking gas will be discharged direct to the atmosphere.

4.6 Remotely controlled shut-off valve

4.6.1 A remotely controlled shut-off valve shall be installed in the gas tube from the LPG fuel tank to the pressure regulator/vaporizer, as close as possible to the pressure regulator/vaporizer.

4.6.2 The remotely controlled shut-off valve may be incorporated into the pressure regulator/vaporizer.

4.6.3 Notwithstanding the requirements of 4.6.1, the remotely controlled shut-off valve may be installed at a location in the engine bay specified by the manufacturer of the LPG system, if a fuel return system is provided between the pressure regulator and the LPG fuel tank.

4.6.4 The remotely controlled shut-off valve shall be installed such that the fuel supply is cut off when the engine is not running or, if the vehicle is also equipped with another fuel system, when the other fuel is selected. A delay of 2 s is permitted for change-over and diagnostic purposes.

4.7 Filling unit

The filling unit shall

- a) be secured against rotation,
- b) be protected against dirt and water,
- c) be fitted outside the vehicle at all times, and
- d) not be permitted in the passenger or luggage compartment, or the inside of the goods carrying area of an open back vehicle.

4.8 Safety devices

4.8.1 Each liquid discharge type fuel tank shall be provided with at least one acceptable spring-loaded internal type safety-relief device.

4.8.2 Vapour withdrawal type fuel tanks shall be furnished with an approved safety-relief valve, which may be mounted on the tank or on the tank valve.

4.8.3 Safety-relief devices on fuel tanks shall be in accordance with the design requirements of the tank.

4.8.4 When a discharge line from a safety-relief device (other than a gas-tight housing) is used it shall be

- a) of metal or of the flexible metallic type (in both cases, other than aluminium and brass),

- b) of such size and location and so maintained as not to be restricted to below the required minimum flow of gas from the safety-relief device, and
- c) capable of withstanding the pressure resulting from the discharge of vapour when the safety-relief device is fully open.

4.8.5 A suitable shut-off valve

- a) shall be provided in the fuel system at a point between the tank and the first-stage regulator, or the inlet of the gas-air mixer,
- b) shall be so designed as to prevent the flow of fuel to the mixer when the ignition is off or when the engine has stopped, and
- c) in the case of industrial trucks, it shall be controlled by an automatic switch (such as an oil pressure switch or a vacuum switch) which should be adequate to control the load.

4.8.6 In the case of a liquid withdrawal system, a suitable hydrostatic-relief valve set to discharge at a pressure not higher than 3 450 kPa and not lower than 2 760 kPa and having its outlet outside the vehicle, shall be installed between the tank shut-off valve and the automatic shut-off valve.

4.9 Vaporizing, regulating and mixing equipment

4.9.1 Vaporizers, regulators, filters and other fuel system components shall be approved and designed for use with LPG fuel and capable of withstanding the maximum pressure likely to be encountered in service.

4.9.2 Unless the vehicle cooling-system drain serves this purpose, each vaporizer shall have a valve or suitable plug (located at or near the lowest point of the section occupied by water or other heating medium) which will permit complete draining of the vaporizer.

4.9.3 Each vaporizer shall be issued with a certificate that includes the following information:

- a) the design pressure; and
- b) the number of the standard to which it was manufactured.

4.9.4 Exhaust gases shall not be used as a direct means of heat supply for the vaporization of the fuel.

4.9.5 Vaporizers shall not be equipped with fusible plugs.

4.9.6 Automatic pressure-reducing equipment shall be installed in a secure manner between the fuel tank and the gas-air mixer (for the purpose of reducing the pressure of the fuel delivered to the gas-air mixer).

4.9.7 All fuel-system components shall be securely fastened to the vehicle in a manner that will prevent displacement or loosening of the components (because of vibration or any other causes).

4.9.8 The gas-air mixer shall be provided with a backfire deflector that will prevent the emission of hazardous flames under backfire conditions.

4.9.9 An oil-bath type or a dry element type of air cleaner shall be considered to be a backfire deflector.

4.9.10 If an oil-bath type of backfire deflector is used, suitable baffles or other means shall be provided to prevent the impingement of the oil on the engine or on components of the electrical or exhaust systems.

NOTE The purpose of the backfire deflector is to minimize the propagation of carburettor backfire flames that may ignite combustible materials present in the engine compartment. A backfire deflector should not be interpreted as being a flame arrester, which is a device for preventing ignition of combustible gases on the outside of the vehicle and is attached to the exhaust system.

4.9.11 The source of air for combustion shall be completely isolated from the passenger compartment, the ventilating system and (when relevant) the air-conditioning system.

4.10 Fuel selection system and electrical components

4.10.1 The electrical components of the LPG-system shall

- a) be protected against overloads, and
- b) have at least one separate fuse provided in the supply cable.

4.10.2 The fuse (see 4.10.1) shall be installed in a known location where it can be reached without the use of tools.

4.10.3 The electrical power supply to LPG system components which also carry gas may not be conducted by a gas tube.

4.10.4 The electrical connections and components in the gas-tight housing shall be constructed such that no sparks are generated.

4.11 Service workshops for LPG-fuelled vehicles

4.11.1 An LPG-fuelled vehicle may be stored and serviced inside a garage provided that there is cross ventilation.

4.11.2 The fuel tank shut-off valve of an LPG-fuel vehicle that is being repaired in a garage shall be kept closed except when fuel is required for engine operation.

4.11.3 A vehicle that has a permanently mounted fuel tank shall be refuelled outdoors.

4.12 Parking of LPG-fuelled vehicles

An LPG-fuelled vehicle shall not be parked near sources of heat, open flames, or similar sources of ignition or, near open pits, unless they are adequately ventilated. These vehicles should not be parked in basements or underground parking bays.

4.13 Certificate of compliance and instructions to users

4.13.1 General

On completion, and before handing over the installation, it shall be inspected, tested and approved by the registered carburation installer. The user shall be issued with a certificate of compliance that indicates that the test has been done and that the installation complies with this part of SANS 10087. A copy of the certificate shall be forwarded to the approving authority. **Amdt 1**

4.13.2 Instructions to users

The registered carburation installer or authorized company representative shall supply the user with a printed instruction sheet or booklet describing the correct and safe handling of the LPG systems and appropriate general emergency procedures.

All the details in 4.13.1 to 4.13.2 (inclusive) shall be discussed with the user to ensure that he or she fully understands the intention of these details. His or her attention shall also be drawn to the information and warnings (when relevant) given in the product brochures supplied.

Amdt 1

5 Retrofitting of vehicles for CNG

5.1 General requirements

5.1.1 All equipment, components, pipework and fittings shall

- a) be of a type and manufacture suitable for their intended use,
- b) comply with any relevant component specification (see UN/ECE Regulation No. 110) and any appropriate certification system, and
- c) be installed and used in accordance with the manufacturer's instructions.

5.1.2 Such equipment, components, pipework and fittings shall be suitable for use with natural gas over the proposed range of operating pressures and temperatures and for the service environment and conditions to which they are to be subjected.

5.1.3 Clear and concise printed instructions, diagrams and any necessary certification documents can be obtained from the manufacturers or distributors of components or component systems.

5.1.4 These (see 5.1.3) shall be for the purpose of assembly, installation, commissioning, maintenance and replacement of the components.

5.1.5 All components shall be manufactured from materials compatible with connecting counterparts, over the range of conditions to which they are to be subjected.

5.1.6 The CNG system shall show no leaks, i.e. stay bubble free for 3 min.

5.1.7 The CNG system shall be installed such that it has the best possible protection against damage, such as damage due to moving vehicle components, collision, grit or due to the loading or unloading of the vehicle or the shifting of those loads.

5.1.8 No appliance shall be connected to the CNG system other than that strictly required for the proper operation of the engine of the motor vehicle.

5.1.9 No component of the CNG system, including any protective material which forms part of such components, shall project beyond the outline of the vehicle, with the exception of the filling unit provided that this does not project more than 10 mm beyond its point of attachment.

5.1.10 Such filling unit (see 5.1.9) shall not be located within 1 m of the ignition source.

5.1.11 No component of the CNG system shall be located within 100 mm of the exhaust or similar heat source, unless such components are shielded against heat.

5.1.12 Due consideration should be given in the design, installation and maintenance of vehicle fuel systems, to the lighter than air property of natural gas.

5.1.13 The design shall be carried out by the responsible engineer, and the installation of the vehicle fuel system components, periodic inspection and maintenance of the gas system on vehicles shall be undertaken by a registered CNG carburation installer. The inspection and service maintenance intervals shall not exceed those recommended by the vehicle manufacturer in accordance with normal vehicle servicing. **Amdt 1**

5.1.14 Any person converting a vehicle to CNG shall be responsible for ensuring that

a) the integrity of the vehicle, in terms of safety, strength, stability, etc, will not be affected unduly by the introduction of the CNG fuel system,

b) the vehicle continues to comply with appropriate legislation,

c) on completion, and before handing over the installation, it shall be inspected, tested and approved by the registered carburation installer. The user shall be issued with a certificate of compliance that indicates that the test has been done and that the installation complies with this part of SANS 10087. A copy of the certificate shall be forwarded to the approving authority, and **Amdt 1**

d) the registered carburation installer or authorized company representative shall supply the user with a printed instruction sheet or booklet describing the correct and safe handling of the CNG systems and appropriate general emergency procedures. **Amdt 1**

5.1.15 All the details in 5.1.14(a) to (d) (inclusive) shall be discussed with the user to ensure that he or she fully understands all the intention of these details. His or her attention shall also be drawn to the information and warnings (when relevant) given in the product brochures supplied. **Amdt 1**

NOTE It may be necessary to consult the vehicle manufacturer for advice.

5.1.16 All pipework shall be routed correctly and supported. **Amdt 1**

5.2 The CNG system

5.2.1 System components

5.2.1.1 A CNG system shall contain at least the following components:

a) gas fuel tank;

b) filling point;

c) pipework and fittings;

d) mixing/injection system; and

e) valves, safety devices and control equipment.

5.2.1.2 These components (see 5.2.1.1) should be restricted with respect to their position and method of location on the vehicle and have specific requirements for their selection, installation and use.

5.2.2 Gas fuel tank(s)

5.2.2.1 Introduction

Compressed natural gas (CNG) is stored in high pressure fuel tanks. A single fuel tank or several fuel tanks manifolded together, securely fixed to the vehicle by means of special mountings, may be used. An isolation valve and pressure relief device are fitted to each fuel tank.

5.2.2.2 Design

Any gas fuel tank shall be designed such that

- a) it is in compliance with SANS 10019 or ISO 11439,
- b) it is of a type approved for use on a vehicle and is suitable for containing CNG at the designed storage pressures and temperatures,
- c) when such a fuel tank is fitted on a vehicle, it shall not be of welded construction, and
- d) it is fitted with a pressure relief device and an isolation valve.

NOTE Consideration should be given to the use of composite material.

5.2.2.3 Fuel tank location, mounting and loading**5.2.2.3.1** A gas fuel tank shall be

- a) mounted such that the effectiveness of any vehicle crumple zone is not impaired,
- b) attached to the vehicle in a secure location by means of an acceptable mounting method,
- c) in a position where the fuel tank and its isolation valve assembly are unlikely to be subjected to impact damage,
- d) capable of being removed from the vehicle for revalidation tests as per SANS 10019, and
- e) of such a weight that, when full or partially full, it does not cause the vehicle loading limitations to be exceeded and does not adversely affect the handling of the vehicle.

5.2.2.3.2 Any gas fuel tank shall be located within the wheel base of the vehicle.

5.2.2.3.3 Where a fuel tank is to be located within the driver or passenger compartment or other space that is not well ventilated, the valves, connections and pipework shall be enclosed in order to contain any gas leakage and the enclosure(s) shall be vented permanently and direct to the outside of the vehicle. This may be achieved by means of either,

- a) placing the fuel tank and its fittings within a durable enclosure which is sealed such that it is gas-tight to the compartment or space and which is provided with permanent ventilation; or
- b) enclosing the neck of the fuel tank and fittings with a specially designed durable envelope that is gas-tight to the compartment and that is provided with permanent ventilation.

5.2.2.3.4 A vehicle boot shall not be considered as a sufficiently well ventilated space.

5.2.2.3.5 Any fuel tank located in the boot shall be provided with the enclosures or envelopes designed as detailed above.

5.2.2.3.6 Any enclosure or envelope shall not contain any ignition source.

5.2.2.3.7 Any enclosure or envelope shall be provided with permanent ventilation to the outside of the vehicle.

5.2.2.3.8 The ventilation opening shall have a free area of not less than 450 mm².

5.2.2.3.9 Any ventilation opening shall be terminated away from any openings into any vehicle compartment, away from any ignition source and in a position where it is not liable to blockage.

5.2.2.3.10 Any pressure relief device contained within any enclosure shall have a separate, dedicated vent line.

5.2.2.3.11 This vent line (see 5.2.2.3.10) may pass within the enclosure vent.

5.2.2.4 Installation of the fuel tank

5.2.2.4.1 Any gas fuel tank shall have its test date checked and inspected externally for

- a) dents, cuts, gouges, bulges, cracks, laminations, wear or corrosion damage, and
- b) other defects such as illegible or unauthorised markings, fire damage or torch burns prior and subsequent to its installation.

5.2.2.4.2 A damaged fuel tank shall not be used.

5.2.2.4.3 Any fuel tank shall be installed such that

- a) the fuel tank and its mounting, do not in any way, weaken the vehicle structure, affect the vehicle's stability or decrease any effective clearances,
- b) it is attached securely to the vehicle by substantial mountings that will prevent the fuel tank from displacement or damage due to vibration or other causes,
- c) if necessary, the point of attachment to the vehicle is reinforced, and
- d) it is positioned, insulated or shielded so that the effects of any heat source, impact or flying debris is minimized.

5.2.2.4.4 Fuel tank mountings should be designed taking account of annex C.

5.2.2.4.5 Following the installation of a gas fuel tank, consideration shall be given to the resultant change in the vehicle's mass.

5.2.2.5 Fuel tank isolation

5.2.2.5.1 Any fuel tank shall be capable of being isolated from the supply pipework by means of an isolation valve.

5.2.2.5.2 Isolation valves shall be

- a) connected direct to each fuel tank but not between the fuel tank and its pressure relief device,
- b) capable of shutting off all the gas flow from the gas fuel tank (except as may be discharged through the pressure relief device),
- c) marked clearly and permanently with the direction of operation,
- d) protected from moisture ingress and foreign matter to ensure that its operation is not in any way inhibited, and

NOTE This is important particularly where a valve is not operated frequently in service.

- e) located in an accessible position to allow for its operation during maintenance of the system.

5.2.2.5.3 Any gas fuel tank valve assembly shall be located in a position where it is protected from mechanical damage.

5.2.2.5.4 The location of any isolation valve should be indicated in the vehicle handbook.

5.2.3 Filling unit or receptacle

5.2.3.1 General

5.2.3.1.1 The filling unit shall be secured against rotation and shall be protected against dirt and water.

5.2.3.1.2 When the CNG fuel tank is installed in the passenger compartment or an enclosed (luggage) compartment, the filling unit shall be located at the outside of the vehicle or in the engine compartment.

NOTE See also annex D for more information.

5.2.3.2 Filling point

The filling receptacle on the vehicle shall be of a specific design which accepts only a compatible CNG filling nozzle (see figure 2).

Amdt 1 |

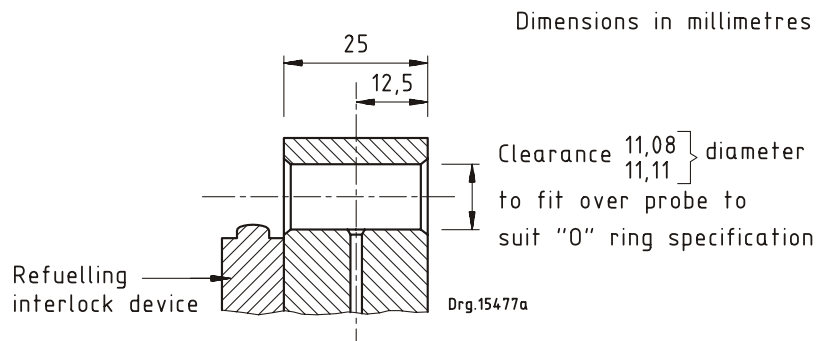


Figure 2(a) — Female (the fitting on the vehicle)

Amdt 1 |

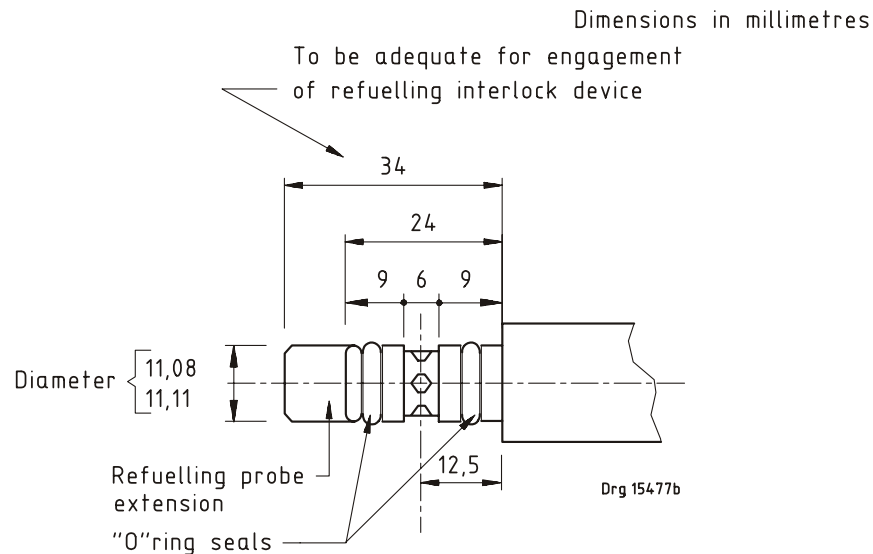


Figure 2(b) — Male 'probe' (the fitting on the refuelling hose)

Figure 2 — Typical 20 MPa – 30 MPa CNG filling nozzle

Amdt 1

5.2.4 Piping, fittings and other components

5.2.4.1 Introduction

High pressure pipework connects the gas fuel tank(s) to the filling point and regulator. Medium or low pressure pipework normally then distributes the gas to the mixing/injection device at the engine.

5.2.4.2 Materials

5.2.4.2.1 Gas pipework, fittings and components shall be selected to ensure

- a) suitability for the full range of operating pressures, temperatures and loadings which may occur, and
- b) resistance to internal and external corrosion unless protected suitably.

5.2.4.2.2 Rigid pipework and fittings shall be made of seamless steel in accordance with SANS 62-2, or to an appropriate equivalent standard or be of suitable metallic alloy material.

5.2.4.2.3 Pipework and fittings shall be sized to an adequate fuel tank filling rate at appropriate measure.

5.2.4.2.4 Any compression joint shall provide positive retention of pipe in the fitting, by means of double inverted flaring of the pipe end or by steel compression fittings which deform the pipe without causing significant weakness.

5.2.4.2.5 Where screwed joints are used, only compatible parallel thread forms that are sealed either by means of metallic washers or spot faced surfaces or by other suitable means which are resistant to leakage during the extremes of service conditions shall be used. However, for a fuel tank neck connection, a taper thread form may be used sealed with a suitable jointing.

5.2.4.2.6 Flexible hose shall be used only for short lengths of pipework within the engine compartment and then only after the pressure regulator, for the purpose of isolating engine vibration and movement from rigid pipework.

5.2.4.2.7 Flexible hose shall be suitable for any combination of the extremes of service conditions and the hose and its connections shall be resistant to leakage during such extreme conditions.

5.2.4.2.8 Hose connections shall be

- a) pre-formed permanent metallic connections, and
- b) fitted with retaining clips that will not permit significant loss of clamping force in service.

5.2.4.2.9 Pipework and fittings shall be free from defects, burrs, scale and other particles.

5.2.4.2.10 Articulated vehicles require special consideration regarding pipework and guidance is given in annex E.

5.2.4.3 Location

5.2.4.3.1 Pipework shall follow the shortest route possible and should, where practical, be of a continuous length between components. In all cases, the number of joints should be kept to a minimum.

5.2.4.3.2 Fittings and connections shall be located in accessible positions to allow subsequent inspection and maintenance. Consideration should be given to the effects of any bodywork, which may be added subsequent to installation.

5.2.4.3.3 Pipework and fittings shall be located within the wheelbase of the vehicle.

5.2.4.3.4 Pipework shall not be located within the driver or passenger compartment or other space that is not ventilated sufficiently, unless it is within an enclosure or envelope as detailed in 5.2.2.3.3.

5.2.4.3.5 Pipework and fittings shall be located so that they

- a) will not be adversely affected by any heat or electrical source,
- b) will withstand the vibration and stress imposed during service,
- c) will be accessible for inspection so far as is reasonably practicable,
- d) are in such position as to prevent the accumulation of any leaking gas and the passage of any such gas into the engine, driver or passenger compartment or other spaces which are not sufficiently well ventilated, and
- e) wherever practical, are protected from damage due to impact or flying debris.

5.2.4.3.6 Pipework and fittings passing through metal sections or panels shall be provided with adequate clearance or shall be protected by grommets or similar means or both.

5.2.4.3.7 Rigid pipework shall be attached only to structural members of the vehicle and shall not bridge between parts of the vehicle that are designed to move relative to each other.

5.2.4.3.8 Pipework and fittings shall not be located in a drive shaft tunnel and shall be positioned to be clear of any suspension or rotating components that move relative to the vehicle.

5.2.4.4 Installation of pipework

5.2.4.4.1 All rigid pipework shall be installed to permit both assembly and slight structural movement, i.e. by the use of pigtailed or U bends.

5.2.4.4.2 All pipework shall be supported effectively at intervals of not more than 600 mm and in such a way as to protect the pipe from chafing.

5.2.4.4.3 The installation of pipework and fittings shall in no way weaken the vehicle structure.

5.2.4.4.4 All fittings shall be tightened to the manufacturer's quoted settings.

5.2.4.4.5 Any bend applied to pipework shall not weaken the pipework or significantly reduce the cross-sectional area of the bore.

5.2.4.4.6 Any damaged pipework and fittings shall be replaced, not repaired.

5.2.5 Mixing/injection system

5.2.5.1 Introduction

Gas is admitted to the engine by one of several techniques. The device may range from a simple mixer to an injection system. The type of mixing/injection system used determines the gas supply pressure downstream of the regulator.

Typically, gas is stored at high pressure and is passed to the regulator where it is normally reduced to low pressure for use in the mixing/injection system, although it should be noted that some mixer/injection systems require the regulator to supply gas at a medium or high pressure.

5.2.5.2 Design

5.2.5.2.1 Mixing/injection devices shall be designed such that

- a) gas is prevented from leaking into the engine compartment, and
- b) the devices do not impair the safe operation of the engine nor invalidate any features covered by relevant legislation, for example when running on any dual or alternative fuel. The devices shall not impair the safety or security of any dual or alternative fuel controls or components.

5.2.5.2.2 Mixing/injection systems shall ensure that gas is supplied to the engine only when it is required and only when the engine is being cranked.

5.2.5.2.3 Mixing/injection systems shall incorporate means to ensure that the correct quantity of gas is delivered to the engine at all times.

5.2.5.2.4 Where a mixture of fuels is delivered to an engine, the mixing/injection system shall stop the flow of gas to the engine should the alternative fuel supply or control system fail.

5.2.5.3 Installation

5.2.5.3.1 Any mixing/injection equipment shall be mounted securely.

5.2.5.3.2 An air filter shall not be installed downstream of a gas mixing/injection device.

5.2.6 Valves, safety devices and control equipment

5.2.6.1 Introduction

A number of isolation valves are included in the system. A regulator is fitted to reduce the high pressure gas from storage to lower pressure required by the mixer/injection system. Several safety devices interlock with the system to cover specific fault conditions and events.

5.2.6.2 General requirements

5.2.6.2.1 Any gas fuel tank shall be fitted with a pressure relief device and an isolation valve (see 5.2.2.1).

5.2.6.2.2 The filling point shall incorporate a means to prevent the flow of gas from the fuel tank back into the filling nozzle (see SANS 10087-8).

5.2.6.2.3 A safety shut-down system shall be provided and shall be designed to take account of the provisions of annex F.

5.2.6.2.4 An automatic shut-off valve shall be located upstream of the regulator to prevent flow of gas through the regulator when the engine ignition is turned off, or when the engine is not running on an alternative or dual fuel supply. This may be an integral part of a regulator unit (the correct functioning of the shut-off valve should be checked at the time of installation).

5.2.6.2.5 Where a vehicle is equipped to operate on more than one fuel, each fuel system shall be equipped with an automatic means of shut-off to prevent the flow of the fuel when not in use (the gas fuel shut-off is satisfied by the automatic shut-off valve required in 5.2.6.2.4).

5.2.6.2.6 A suitable deceleration switch with a manual reset facility shall be fitted to the vehicle.

5.2.6.2.7 Such a switch (see 5.2.6.2.6) shall be

- a) connected to an automatic shut-off valve to stop the flow of gas, at a point as close as reasonably practical to the gas fuel tank, in the event of vehicle impact,
- b) triggered automatically between the limits of 6 g to 12 g deceleration in all planes, except the vertical, when a deceleration pulse of sixty milliseconds is encountered, and
- c) mounted on a structurally stiff section of the vehicle (away from suspension attachments, engine mountings and bonnet, body and door slam points) in order to prevent premature activation and it shall be in an accessible position for resetting.

5.2.6.2.8 The vehicle shall be equipped with a gas contents gauge located in the driver's compartment.

5.2.6.2.9 The gas gauge (see 5.2.6.2.8) shall be of a type which shall not permit gas to enter the compartment upon failure of the gauge or its connections.

5.2.6.2.10 Any electrically operated valve shall be constructed so as to open when electrical power is applied and to close when electrical power is removed.

5.2.6.2.11 Where a vehicle is equipped to operate on more than one fuel, a fuel selection system shall be installed which

- a) has a readily accessible control switch within the driver's compartment, clearly marked for the selection of each fuel or fuel mixture,
- b) has a change-over system, operated by the control switch mentioned above, to prevent the operation of more than one fuel at a time (except for the fuel remaining in the common system during change-over or where there is a mixed fuel system), and
- c) does not impair the safety of the engine or fuel system.

5.2.6.2.12 All of the components mentioned in 5.2.6.2.11, shall be

- a) installed in positions which are accessible for inspection and maintenance,
- b) mounted securely and protected from mechanical damage, and
- c) positioned away or protected from any heat or electrical sources.

5.2.6.2.13 Any electrical wiring, equipment and fittings shall be

- a) to the standard and rating of the vehicle's electrical circuitry, and
- b) protected by suitable fuses and be insulated suitably.

5.2.6.2.14 All electrical wiring shall be installed correctly and be clipped suitably or contained within a loom.

5.2.6.2.15 Electrical harnesses shall not be

- a) attached either directly or indirectly to the gas pipework or fuel system components,
- b) routed over sharp edges or abrasive components, unless shielded, and
- c) routed where they may be subject to mechanical damage.

5.2.7 Regulators

5.2.7.1 Design

The system pressure regulator shall be designed such that

- a) it has a preset pressure and flow rating suitable for the part of the system to which it is attached,
- b) it incorporates a means to protect the system downstream of the regulator from the upstream pressure in the event of failure of or leakage from the regulator,
- c) it is marked clearly and permanently with the fuel type, pressure and flow direction, and
- d) if the engine cooling system is utilised within the regulator, passage of gas into the engine cooling system is prevented.

5.2.7.2 Location

5.2.7.2.1 Any regulator shall be installed such that

- a) it is in an accessible position for inspection and maintenance,
- b) it is in a position where it is protected from heat sources (particularly exhausts, manifolds and pipes),
- c) it is in a position where, as far as it is practical, any purpose provided breather holes are prevented from being blocked, and
- d) it is on a secure mounting.

5.2.7.2.2 Any regulator shall be located within the wheelbase of the vehicle.

5.2.7.2.3 Any regulator shall not be installed inside the driver or passenger compartment or other space which is not sufficiently ventilated, unless it is contained within an enclosure or envelope in accordance with 5.2.2.3.3.

5.2.7.3 Installation

5.2.7.3.1 Regulators shall not be attached direct to the engine assembly.

5.2.7.3.2 Where the regulator embodies a heat exchanger, operated from an engine cooling system, the regulator shall not be adversely affected by the engine coolant or any recognized additives.

5.2.7.3.3 A filter shall be fitted upstream of the regulator if specified by the manufacturer or if required by the storage system.

5.3 Pressure testing

NOTE See annex G for the schematic procedure.

5.3.1 General

5.3.1.1 On completion of the installation, a strength or pressure test of the high pressure pipework i.e. upstream of the regulator, shall be undertaken as detailed below.

NOTE Procedures are also included for medium and low pressure parts of the system.

5.3.1.2 It is essential that tests are carried out in a safe and competent manner by a registered installer(s) trained suitably for the task and in accordance with the safety procedures (see also 5.3.1.3 to 5.3.1.5).

5.3.1.3 The safety of all persons, whether or not involved in the testing, is of paramount importance and no procedure shall be allowed which would violate this concept.

5.3.1.4 Safety precautions shall, as far as possible, ensure that no person is exposed to injury should any part of the pipework system fail during the test.

5.3.1.5 All persons engaged in the test shall be fully instructed regarding the possible hazards involved in pneumatic testing.

5.3.1.6 Valves shall be tested as appropriate at the system operating pressure.

5.3.2 Test area

5.3.2.1 A test area shall be defined, including the vehicle under test and all test equipment.

5.3.2.2 Access to the test area shall be restricted during the test to the persons undertaking the test.

5.3.2.3 The boundaries of the test area shall be marked and identified with warning notices.

5.3.3 Apparatus

5.3.3.1 An inert gas, for example nitrogen.

5.3.3.2 Standard test gauges, calibrated at acceptable intervals, complying with EN 837-1 and of at least 150 mm diameter.

5.3.3.3 A leak detection fluid, that is compatible with the pipework materials.

5.3.4 Test procedure

5.3.4.1 Carry out a visual inspection of all the fuel system components prior to the admission of inert gas to ensure the following:

- a) the installation complies with these procedures and with any instructions provided with installation components;
- b) all components are to the correct rating and are fitted correctly; and
- c) all connections have been made in accordance with the components manufacturer's requirements.

5.3.4.2 Inspect any test certificates supplied with components.

5.3.4.3 On completion of the checks detailed in 5.3.4.1, carry out the following strength or pressure testing procedure in a designated test area that is well ventilated, with access restricted to only the person(s) undertaking the test:

- a) disconnect and seal temporarily, the final downstream regulator outlet connection;
- b) ensure that any fuel tank isolation valves are fully open, unless the integrity of the fuel tank/valve/pressure relief device joints has been checked prior to installation, in which case ensure that the fuel tank isolation valves are fully closed;
- c) open any automatic shut-off valves i.e. electrically energize solenoids (having checked the correct functioning of such valves at the time of installation);
- d) slowly pressurize the fuel system, via the fill point, with the inert gas, to a pressure of 700 kPa (checking the vehicle gas fuel gauge to establish that the inert gas has entered the system) then check for leaks using leak detection fluid;
- e) fully close any fuel tank isolation valves (if not already closed in (b) above);
- f) progressively pressurize the fuel system to a final pressure corresponding to 1,25 times the maximum operating pressure of the system;
- g) upon reaching the final strength test pressure, isolate the pressure source and allow the pressure to stabilize, monitoring for a 10 min period. No significant drop in pressure should be registered over the 10 min period;
- h) following a successful 10 min strength test, carefully reduce the pressure in the system to the maximum operating pressure and check all joints for leakage using leak detection fluid (as any minor leaks may not have registered in the 10 min test). Correct any leaks in the system before proceeding;
- i) if a pressure drop is indicated in the 10 min test and a component failure cannot be identified, the cause may be attributable to a defective isolation valve or regulator which is allowing test gas to pass out of the system into the fuel tank or regulator chambers;
- j) before any attempts are made to correct leaks, depressurize the system safely. When repairs have been effected, the system will require retesting;
- k) following the completion of a successful strength/pressure test, safely depressurize the system;
- l) reconnect the regulator outlet to the system once the integrity of the downstream pipework has been established;

- m) slowly fill the gas fuel tank with CNG and carefully recheck the fuel tank or isolation valve or pressure relief device connections for leaks. Correct any leaks following safe depressurization of the system and recheck the connections upon refilling;
- n) when the engine is first started, recheck the fuel system downstream of the regulator for leaks and correct operation. Correct any leaks before proceeding; and
- o) following successful testing, operation and adjustment of the system, visually reinspect the whole of the system.

5.4 Identification of CNG fuelled M₂, M₃ and N category vehicles

Identification of CNG fuelled M₂, M₃ and N category vehicles shall be marked and identified in accordance with the requirements of annex B.

5.5 Servicing and repair

5.5.1 In terms of servicing and repair, CNG fuelled vehicles differ from liquid fuelled vehicles primarily in the fuel storage, operating pressures and the gaseous nature of the fuel (which is lighter than air).

5.5.2 Servicing and repair of the CNG fuel system and its components shall be undertaken only by registered installers and only in work areas where the following conditions are observed:

- a) vehicles undergoing repairs should have their fuel tank isolation valves closed and the gas in the supply line exhausted by running the engine or by depressurizing, in a well ventilated area, unless the fuel is required for engine operation;
- b) any vehicle with suspected leaks in the CNG fuel system should have its gas system isolated and be moved safely to a well ventilated location, preferably in the open air, for the leak to be identified and the system depressurized;
- c) work on vehicles that do not have their fuel tanks isolated should only take place in a work area having a suitably designed and effective ventilation system;
- d) a non-mechanical ventilation system should have permanent ventilation openings divided equally at high and low levels, opening direct to the atmosphere;
- e) all high level ventilation should be provided as near as practical to the roof level;
- f) if a mechanical ventilation system is provided, then work should be undertaken in the work area only if the mechanical system is shown to be fully operational;

NOTE Some form of interlocked failure warning may be appropriate.

- g) the work area shall be kept clear of fixed sources of heat or potential ignition sources to within 3 m of stationary vehicles; and
- h) no source of ignition shall be situated above stationary vehicles nor above the 3 m surrounding clearance area.

5.5.3 Persons carrying out other work on the vehicle shall be made aware that the vehicle contains a CNG fuel system and that any appropriate action may need to be taken.

5.5.4 Vehicles undergoing repairs involving welding or the application of heat close to fuel compartments, fuel lines or within 1 m of the gas fuel tank, for example, paint baking ovens, shall have the fuel component line or fuel tanks either removed or shielded to prevent temperature rise or damage from weld spatter, etc.

5.5.5 Damaged gas fuel tanks shall either be replaced or revalidated before reuse.

5.5.6 Damaged gas fuel tanks shall not be repaired.

5.5.7 Any gas fuel tank which is damaged shall be disposed of by safely purging its contents then mutilating the fuel tank threads to prevent its reuse.

5.5.8 Damaged fuel lines shall not be repaired and in all cases they shall be replaced.

5.5.9 Any maintenance requirements for individual gas fuel system components or for the gas fuel system as a whole shall be added to the vehicle documented servicing schedule and shall be adhered to.

NOTE The integrity of any ventilation paths and openings for the gas fuel system is to be checked at prescribed intervals.

6 Forklift trucks

6.1 General

6.1.1 A fuel tank on a vehicle that does not operate on a public road may be permanently mounted or removable.

6.1.2 A removable fuel tank shall be provided with effective valve guards and should be so designed that it can be secured easily and effectively on a vehicle.

NOTE This requirement does not apply to fuel tanks on ordinary domestic or industrial type mobile equipment (e.g. sweepers).

6.1.3 Cylinders with appurtenances attached to the dome shall be designed to engage with a horizontal positioning pin on the vehicle.

6.1.4 Cylinders with appurtenances attached to the shell shall rest on a cradle.

6.1.5 When removable fuel tanks are used, means shall be provided in the fuel system to minimize the release of fuel when the fuel tanks are exchanged.

6.1.6 This (see 6.1.5) shall be achieved by the use of an automatic quick closing coupling in the fuel line, i.e. a type in which both halves (portions) close automatically when uncoupled.

6.2 Installation requirements

6.2.1 Construction, testing and marking

6.2.1.1 Fuel tanks intended for use on forklift trucks shall comply with a standard approved for this purpose (see also SANS 10019).

6.2.1.2 Revalidation and inspection of tanks shall be in accordance with SANS 10019.

6.2.1.3 On a removable fuel tank, the filler valve may be a hand-operated shut-off valve combined with an excess-flow valve.

6.2.1.4 Flexible hose between a removable tank and any fixed fuel system shall be of sufficient length to allow for vibration of and relative movement between parts and shall comply with the requirements of SANS 252.

Amdt 1

6.2.1.5 Components and installation shall be as per requirements of clause 4 of this standard.

7 Stationary and portable engines in buildings

7.1 The use of fuel from a cargo vessel for a stationary engine may be permitted provided that the wheel of a vehicle on which the cargo vessel is mounted is securely chocked.

7.2 A fuel tank from which only vapour is to be withdrawn shall be so installed and equipped with suitable connections as to minimize the danger of the accidental withdrawal of liquid.

7.3 All buildings housing a gas driven engine shall comply with the appropriate requirements of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), as well as the relevant clauses given in SANS 10400.

7.4 The gas installation shall comply with the appropriate requirements of SANS 10087-1 and SANS 10087-3, as applicable.

7.5 All engine rooms shall be well ventilated at floor level, with the ventilation leading to the outside atmosphere.

7.6 An engine should not be installed below ground level of any building.

7.7 Where this (see 7.6) is unavoidable, the engine room shall be permanently vented in an approved manner (and with an uninterruptible electric power supply being available).

7.8 Each opening from the engine room into another section of the building shall be provided with a suitable fireproof door that complies with the requirements given in SANS 10400.

7.9 Regulators and safety-relief devices on an engine installed in a building shall, when they include built-in gas vents, be vented to the outside, and the point of discharge should be at least 1,5 m away from any building opening. Such venting is not necessary in the case of an engine that has a combination of a fuel-vaporizing, fuel-pressure-reducing and fuel-metering device, provided that an automatic shut-off valve is installed immediately ahead of the device.

7.10 A length of flexible hose (not exceeding 1,0 m) shall be so installed between the engine and the fuel line as to eliminate the possibility of damage to the fuel line caused by engine vibration.

7.11 Electrical installations in a gas driven engine room shall comply with the requirements of SANS 10086-1 and SANS 10108.

7.12 A safety-relief device shall have direct communication with the vapour space of the fuel tank.

7.13 For the removable type fuel tanks, the outlet shall be directed upwards (within 45° of the vertical) in such a manner as to prevent escaping gas impinging on fuel tanks, on parts of the vehicle or on vehicles in adjacent lines of traffic.

7.14 Each vent pipe shall be fitted with a captive, loosely fitting rain cap.

7.15 An atmospheric-type regulator (zero governor) should be considered adequate as an automatic shut-off valve only in cases of outdoor operation (such as on farm tractors, construction equipment, irrigation pump engines and other outdoor stationary engine installations) and provided that it does not have a permanent gas-bleed bypass to the engine which prevents the zero governor from acting as a shut-off valve.

7.16 When using zero governors of the bypass type, a separate automatic fuel shut-off valve shall be provided.

Annex A
(informative)

Typical conversion of a petrol engine

Figure A.1 shows how to change a petrol-operated engine to operate on LPG fuel.

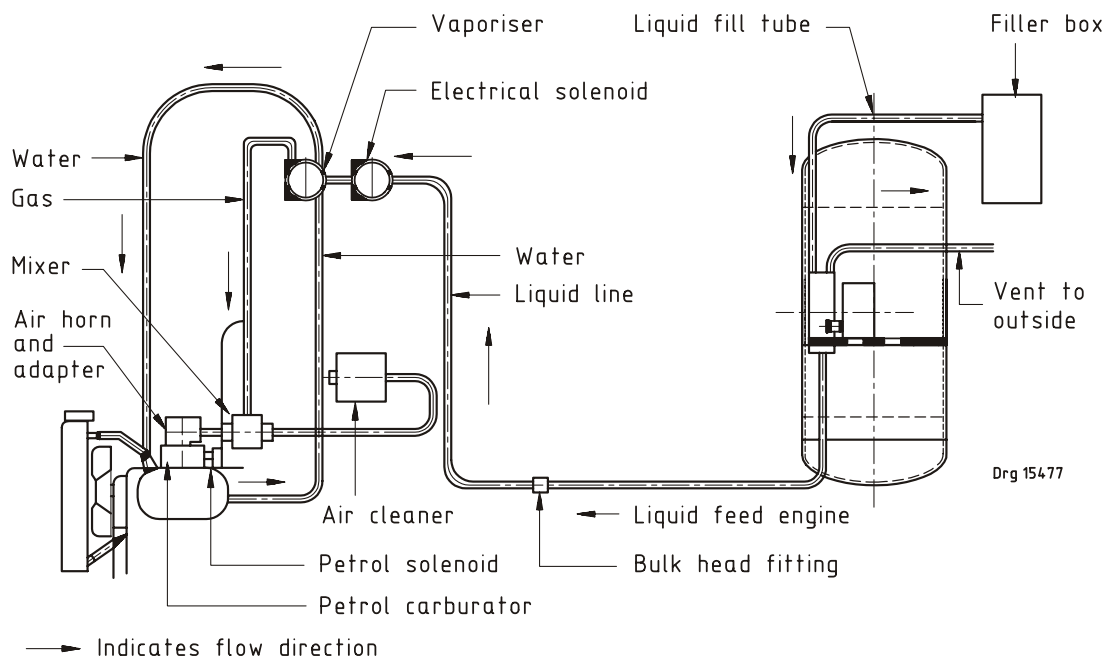


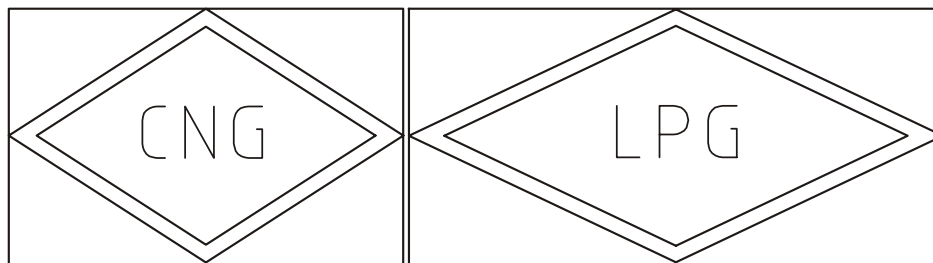
Figure A.1 —Typical conversion of a petrol engine

Annex B

(normative)

**Provisions regarding CNG and LPG identification
of M₂, M₃ and N category vehicles**

B.1 The vehicles shall bear the following signs, as appropriate.



Drg.15200a

B.2 The signs shall consist of a sticker which is weather resistant.

B.3 The colour and dimensions of the sticker shall fulfil the following requirements:

a) Colours

Background:	Green
Border	white or white reflecting
Letters	white or white reflecting

b) Dimensions

Border width	4 mm – 6 mm
Character height	≥ 25 mm
Character thickness	≥ 4 mm
Sticker width	110 mm – 150 mm
Sticker height	80 mm – 110 mm

c) The word “LPG” or “CNG” as appropriate, shall be centred in the middle of the sticker.

Annex C

(informative)

Fuel tank mounting, design guidelines

The following considerations should apply when designing mountings:

C.1 Fuel tank(s) should be removed for statutory examination without undue dismantling or risk of damage to the vehicle.

C.2 The mountings should provide location for the fuel tanks such that in a survivable accident the fuel tanks do not become detached nor have potential to cause injury. This applies to fuel tanks mounted internally or externally to the vehicle.

C.3 At least four points of attachment should be provided for each fuel tank, spread as far apart as possible and arranged to give equal loading at each point of attachment.

C.4 Each mounting point should be reinforced in order to prevent “pull-through” or tearing of the mounting points when the fuel tank is subjected to design loads.

C.5 The guidelines of this annex should be deemed to be met if the fuel tank is secured to the motor vehicle by at least

- a) two straps per fuel tank,
- b) four bolts, and
- c) appropriate washers or plates if the body panels at that location are of single thickness.

C.6 When using material of grade Fe 370, the fixing bolts should be of class 8.8 of ISO 898-1, and have the dimensions specified in table C.1 below:

Table C.1 — Fixation of LPG and CNG cylinders

1	2	3	4
Fuel tank content L	Minimum dimensions of the washer or plates mm	Minimum dimensions of the fuel tank straps mm	Minimum diameter of bolts mm
Up to 85	round: 30 × 1,5 round: 25 × 2,5	20 × 3 30 × 1,5	8
85 – 100	round: 30 × 1,5 round: 25 × 2,5	30 × 3 20 × 3 ¹	10 8 ¹
100 – 150	round: 50 × 2 round: 30 × 3	50 × 6 50 × 3 ²	12 10 ²
More than 150	Provisions of UN/ECE Regulation No. 67 series of amendments, for LPG fuel tanks, or UN/ECE Regulation No. 110 for CNG fuel tanks		
¹ In this case the fuel tank should be secured by at least three fuel tank straps.			
² In this case the fuel tank should be secured by at least four fuel tank straps.			

C.7 Reinforcements should

- a) spread the loads unto the existing load bearing areas of the vehicle (i.e. the under-frame longitudinals, cross-members, sills, suspension pick-up points and the like), and
- b) be contoured to the vehicle surfaces against which they bear.

C.8 When fasteners pass through hollow sections, anti-crush tubes should be provided.

C.9 The materials used for the construction of fuel tank mountings should be non-corrodible or coated to current automotive standards with an anti-corrosion treatment, the treatment not being subject to damage during the fuel tank installation process.

C.10 A fuel tank should be securely mounted on the vehicle to prevent it from jarring loose, slipping or rotating, and the fastenings should be designed and constructed with a minimum safety factor of four, based on applied forces of 10 times the mass of the filled tank in the longitudinal (along the length of the vehicle) direction and twice the mass of the filled tank in all other directions.

C.11 Regular checking of the tightness and freedom from corrosion of all fuel tank fastenings and reinforcements should be carried out during maintenance procedures.

Annex D

(informative)

Filling receptacle for CNG fuel tanks

D.1 In order to initiate the establishment of compatibility of filling equipment and in absence of appropriate United Kingdom or European standards, the American Gas Association (AGA) fuelling connection device AGA NGV 1, is suggested as a specification for a filling receptacle in South Africa.

D.2 Vehicle receptacles which have been manufactured to the AGA NGV 1 requirements and are of a type appropriate to the vehicle storage pressure, may be deemed acceptable and therefore should be compatible with filling station dispenser nozzles found in South Africa.

Annex E

(informative)

Connections for articulated vehicles

E.1 Introduction

In some vehicle designs, the chassis may not be a continuous rigid structure, for example on articulated vehicles. On such vehicles, the complete fuel system, including the fuel tanks, normally will be located on a single rigid chassis structure with the power train. Where this is not possible, an articulating connector and additional associated components will be required to connect the two separate parts of the fuel system.

Principles given in E.2 to E.5 apply to such connections.

E.2 General

E.2.1 The articulating connector between two chassis structures should operate at medium or low pressure (i.e. the high pressure being regulated at the point of exit of the cylinder or manifold).

E.2.2 Any connector should be of a type suitable for CNG systems, be designed to accept a compatible nozzle without the use of adaptor fittings and not be interchangeable with connections for other services.

E.2.3 The pipework on each structure should terminate at a fixed point capable of withstanding a breakaway force of 200 N in any direction.

E.3 Disconnection facilities

E.3.1 Separation of the articulation joint should be achieved in a fail-safe manner designed to minimize the volume of gas released.

However, the vehicle manual should make it clear that disconnection will be undertaken only in a well ventilated area.

E.3.2 Following disconnection, a fail-safe method should be provided to prevent accidental release of gas from any fuel tank or associated pipework.

E.3.3 Disconnection devices should be of a design to prevent unauthorized interference.

E.3.4 The ingress of dirt during disconnection, separation and reconnection should be prevented.

NOTE Dust caps, attached to the system, will enable all fuel system pipes to be protected from the ingress of dirt when joints have been disconnected.

E.3.5 It may be necessary to fit a fuel line filter in order to protect fuel system components. Filters may be necessary to protect upstream components during the filling process and downstream components during engine operation.

E.3.6 The articulating joint should be supported properly and protected at all times.

E.4 Breakaway couplings

E.4.1 A breakaway coupling is required to form part of the articulating connector, designed to separate when a breakaway force of 200 N or greater is applied in any direction.

E.4.2 In the event of the operation of the breakaway coupling, it is important that gas release be minimized by automatic isolation of the fuel tanks and, where applicable, allowed for, in the design of the fuel system.

E.5 Stowage

When either part of an articulated vehicle is used with a unit that does not operate on CNG, the components of the articulating connector should be designed to stow away and not to cause interference with the operation of the vehicle.

Annex F

(normative)

Safety shut-down system

F.1 Introduction

Under fault conditions that result in excessive fuel flow, for example a gas system or supply component failure, an engine malfunction, severe vehicle impact fire etc., CNG vehicle installations should include a means of preventing excess flow of gas while not impeding the fuel tank pressure relief mechanism. An example of such means is a solenoid valve mounted either entirely within the fuel tank or at the outlet from it. The system which prevents the flow of gas in these circumstances is known as the safety shut-down system.

F.2 Fail-safe

The safety shut-down system will be fail-safe if, upon failure of any part of the system, including loss of electrical power, the isolation valve closes and remains closed until the system is rectified.

F.3 Suitability for use

The system should be suitable for use in the environment in which it is installed and continue to function reliably for the life of the gas installation on the vehicle. A stored shelf life for the system of at least 10 years is required when suitably packaged and maintained in the environmental conditions declared by the manufacturer.

F.4 Inspection and test

On completion of the vehicle installation, including functional and quality checking procedures, the safety shut-down system should require no further maintenance or overhaul for the life of the gas installation. The system shall be designed and installed in such a way as to permit periodic inspection for damage (for parts mounted outside the fuel tank) and to permit demonstration of continued ability to function by means of a simple test.

F.5 Warning of operation

A visual or audible warning to the vehicle driver that the safety shut-down system has operated will be needed. Under such conditions and where a vehicle is fitted with an alternative liquid fuel supply, a change-over of fuels, in a safe and proper manner, is permitted.

F.6 Impact protection

A means shall be provided to detect a vehicle impact of which the deceleration exceeds 6 g and, under these conditions, to cause operation of the safety shut-down system (see 5.2.6.2.6 and 5.2.6.2.7).

F.7 Engine start-up and engine failure

The safety shut-down system shall be able to prevent gas flow at all times when the engine is not proved to be rotating under its own power. However, to permit start-up, a maximum of five seconds is permitted between energization of the ignition system and proving of the engine rotation interlock, during which time the safety shut-down system need not be operative. However, a subsequent engine failure should result automatically in operation of the safety shut-down system.

F.8 Additional protection

F.8.1 Excess flow operation

A means to prevent the flow of gas from the fuel tank exceeding 1,25 times the theoretical design maximum, and to isolate the fuel tank in the event of any regulator pressure relief device venting occurring should be considered. Such means may include a self-contained valve not requiring an external power source and being made to operate through the use of sensors and associated electronics i.e. active flow operation.

F.8.2 Leak detection

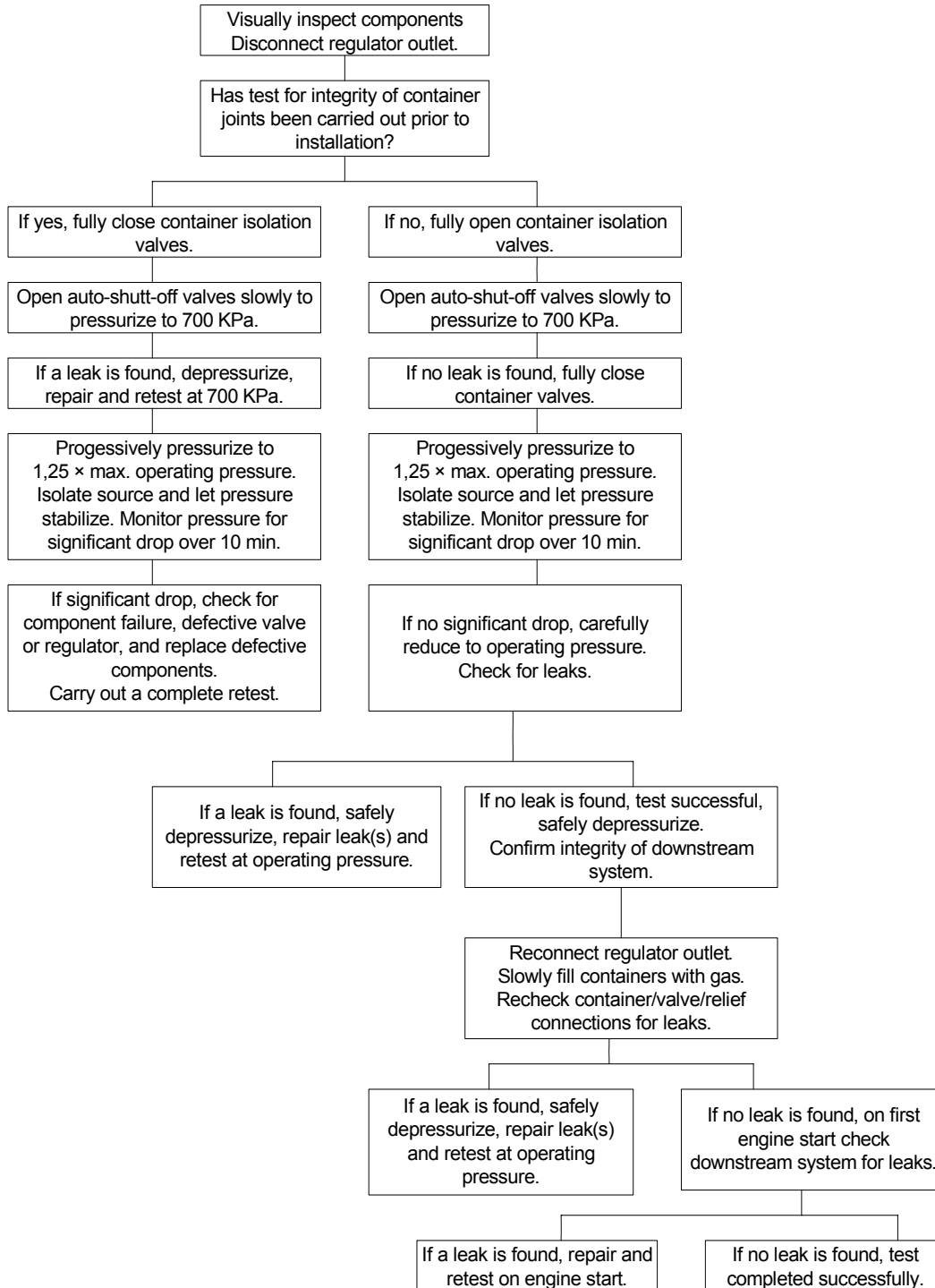
A means to detect the loss of fuel tank pressure, between engine shut-down and subsequent start-up, that would cause a fuel tank pressure change equivalent to a gas flow of 1,25 times the theoretical design maximum for a period of 1 min, under these conditions, to cause operation of the safety shut-down system should be considered.

F.8.3 Fire protection

A means to detect a rapid increase in ambient temperature that would cause a fuel tank pressure change equivalent to a gas flow of 1,25 times the theoretical design maximum for a period of 1 min and, under these conditions, to cause operation of the safety shut-down system should be considered.

Annex G

(informative)

Pressure/strength test procedure at a glance

Bibliography

ASME, Boiler and pressure vessel code section VIII – Division 1: Rules for the construction of pressure vessels.

ISO 898-1, Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs.

SANS 1792-3 (SABS 1792-3), Refillable welded steel gas cylinders – Part 3: LPG fuel tanks for fork lifts and stationary engines.

SANS 4706/ISO 4706 (SABS ISO 4706), Refillable welded steel gas cylinders.